

# Underwater Image Enhancement

Marshall Mathews<sup>1</sup>, Riya Chummar<sup>1</sup>, Sandra<sup>1</sup>, Ms. R. Sreetha E, S<sup>2</sup>

<sup>1</sup>Student, <sup>2</sup>Associate Professor

<sup>1,2</sup>Department of Computer Science, Sahrdaya College of Engineering and Technology, Thrissur, Kerala, India

## ABSTRACT

Underwater image enhancement is a challenging task and has gained priority in recent years, as the human eye cannot clearly perceive underwater images. We introduce an effective technique to develop the images captured underwater which are degraded due to the medium scattering and absorption. Our proposed method is a single image approach that does not require specialized hardware or knowledge about the structure of the hardware or underwater conditions. We introduce a new underwater image enhancement approach based on object detection and gamma correction in this paper. In our method, we first obtain the restored image on the base of underwater image model. Then we detect objects using object detection. Finally, the image is gamma corrected. adapted. Experimental results on real-world as well as mock underwater images demonstrate that the proposed method is a simplified approach on different underwater scenes and outperforms the existing methods of enhancement.

**KEYWORDS:** Image Enhancement, gamma-correction, object detection

**How to cite this paper:** Marshall Mathews | Riya Chummar | Sandra | Ms. R. Sreetha E, S "Underwater Image Enhancement" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-4, June 2020, pp.1303-1306, URL: [www.ijtsrd.com/papers/ijtsrd31467.pdf](http://www.ijtsrd.com/papers/ijtsrd31467.pdf)



Copyright © 2020 by author(s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



## I. INTRODUCTION

The image enhancement approach is used for recovering perception of information in underwater images. There are many factors within underwater and these factors can easily affect captured images. In other words, clarity of image can be corrupted by diffusion and light inclusion. Eventually, a single colour can dominate the whole image. Other types of degradations such as low contrast, color loss, noise due to floating particles can also affect the underwater images. Besides underwater photography, underwater imaging has also been an important area of interest in different branches of scientific research such as detection of man made objects, inspection of underwater infrastructures and cables, control of underwater vehicles, marine biology research, and archaeology. Physical properties of the water medium causes degradation effects in underwater images that are not present in terrestrial images. Light is exponentially attenuated as it travels in the water and the resulting scenes suffer from poor contrast and haziness. Light attenuation confines the visibility distance to about five meters or fewer in turbid water and twenty meters in clear water. The light attenuation process is caused by scattering and absorption. This effects the overall performance of underwater imaging systems. The scattering causes changes in the light propagation direction, while the absorption substantially reduces the light energy. They produce foggy appearance and contrast degradation, which makes distant objects misty.

Absorption and scattering effects are due not only to the water itself but also to other components such as dissolved organic matter or small observable floating particles. The

presence of the floating particles known as marine snow (highly variable in kind and concentration) increase absorption and scattering effects. Our approach builds on the fusion of multiple input images, but derives the two inputs images to combine by correcting the contrast and by sharpening a white-balanced version of a single original input image. The white balancing stage aims at removing the color cast which is induced by underwater light scattering, so as to produce a natural appearance of the sub-sea images. The multi-scale implementation of the fusion process results in an artifact-free blending. The next section briefly surveys the optical specifications of the underwater environment, before summarizing the work related to underwater dehazing. Then we present our novel white-balancing approach, especially designed for underwater images. The main components of our fusion-based enhancing technique, include inputs and associated weight maps definition.

Many researchers have attempted in past to process such degraded underwater images in order to restore their natural visual appearance. In much of the previous works, the problem has been tackled by using specialized hardware and polarization filters. These methods provide significant improvement, however they suffer from a number of issues such as cost of equipment and processing time which reduces their practical applicability. Another group of researchers proposed single or multiple image methods using a blend of statistical and fusion based techniques. The results shows better efficiency both in terms of visual appearance as well as processing time required. However

they suffer from poor edge quality, amplified noise and unnatural look. Therefore there is a need of an efficient method which can restore natural visuals of images captured under deep sea.

## II. RELATED WORK

The existing underwater dehazing techniques can be grouped into several different classes. One of the important class corresponds to the methods using specialized hardware. For example, the divergent-beam underwater Lidar imaging (UWLI) system uses a laser-sensing or an optical technique to capture the turbid underwater images. Although there are rapid developments of underwater robotic vehicles in recent years, the underwater visual sensing and underwater imaging is still regarded as a major challenge, particularly in turbid water condition. Currently, a divergent-beam underwater Lidar imaging also known as UWLI system has been finished. The end result is highly improved intensity and contrast of the detected images. Based on our newly designed series targets, we propose to demonstrate UWLI in a small 3 m water tank, and show the fast range-gated phenomenon in water much more clearly. The attenuation coefficients in turbid waters are 1.0 m and 0.23m, respectively.

A second class consists of polarization-based methods. These approaches use several images of the same captured scene with different degrees of polarization. For instance, Schechner and Averbuch make use of the polarization associated to back-scattered light to estimate the transmission map. Although being effective in recovering distant regions, the polarization techniques are not applicable of video acquisition, and are therefore of limited help while dealing with dynamic scenes.

A third class of approaches employs multiple images or an approximation of the scene model. Narasimhan and Nayar made use of changes in intensities of scene points under different weather conditions in order to detect depth discontinuities in the scene. Deep Photo system is able to restore images by employing the existing geo referenced digital terrain and urban 3D models. Since this additional information (images and depth approximation) is generally not available, these methods are not practical for common users.

There is a fourth class of methods which exploits the similarities between light propagation in fog and under water. Recently, several single image dehazing techniques have been introduced to restore images of outdoor foggy scenes. These dehazing techniques reconstruct the intrinsic brightness of objects by inverting the visibility model by Koschmieder. Despite this model was initially formulated under strict assumptions, some works have relaxed those strict constraints and have shown that it can be used in heterogeneous lighting conditions and with heterogeneous extinction coefficient as far as the model parameters are estimated locally. However, the underwater imaging appears to be more challenging, due to the fact that the extinction due to scattering depends on the light wavelength, i.e. on the color component.

## III. MOTIVATION

The recent Kerala floods have shown us the need for technologies that can dynamically enhance the underwater

images for the purpose of identification, rescue and survey. Underwater image enhancement has also been an area of major concern in the recent times.

Image enhancement has become a crucial step in image processing. Images taken by consumer digital cameras usually lack details in the underwater areas if the camera has an improper setting or the light condition is poor. Due to low visibility, the image details are lost, and colors in images are washed out. Underwater images are essentially characterized by their poor visibility because light is exponentially attenuated as it travels in the water and the scenes result poorly contrasted and hazy. Light attenuation limits the visibility distance at about twenty meters in clear water. The light attenuation process is caused by absorption and scattering. The absorption and scattering processes of the light in water influence the overall performance of underwater imaging systems. Image enhancement can be widely used in color correction, contrast enhancement, and noise reduction, etc. Underwater image enhancement aims at improving the visibility of objects, and increasing image quality.

## IV. SYSTEM ARCHITECTURE

The image enhancement method implements a two step strategy, combining image fusion and white balancing, to intensify underwater images without resorting to the explicit inversion of the optical model.

### A. Camera Module

The raspberry camera module is a 5mp camera capable of 1080p video and still images and connects directly to your Raspberry Pi. The ribbon cable is connected to the Camera Serial Interface port on the Raspberry Pi.

Dimensions: 25mm x 20mm x 9mm 5mp Resolution  
2592 x 1944 pixel static images

### B. Remote Control Module

The RF Remote Control module is primarily designed for remote control applications. Taking a line high on one side causes a line to go high on a paired system which can then be used to activate external circuitry. Some of the Remote Control RF Modules have the remote control functionality built in while others are transparent modules that get paired with remote control encoders, decoders or transcoders.

Both the camera module and RC module are controlled and run by the Arduino Uno. The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits

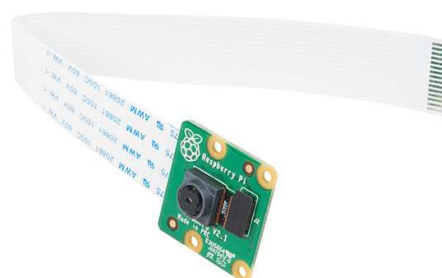


Fig.1. Camera Module



Fig.2. RC Module

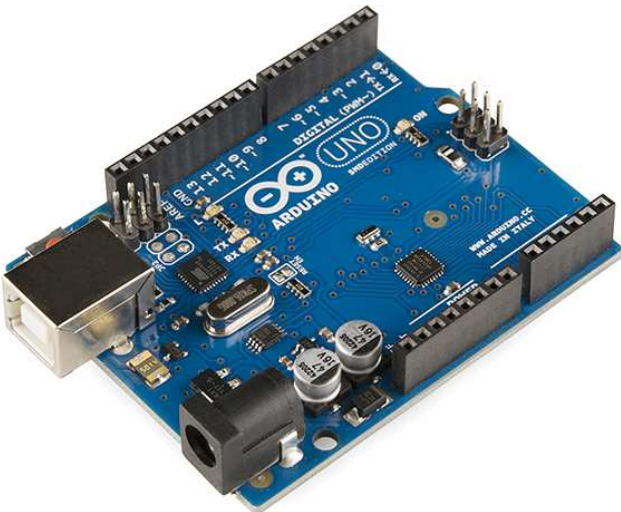


Fig.3. Arduino Uno

C. Miscellaneous

A use case diagram is a graphic representation of the interaction among the elements of the system. A use case is a methodology used in system analysis to identify, clarify and organize system requirements. Its initiated by an actor provides value to that actor and is a goal of the actor working in that system. The actors usually individuals involved with the system defined according to their roles. Here we have mainly two actors user and admin or system. System captures image for image or video enhancement. The system can access all the enhanced images. The user access the best enhanced image.

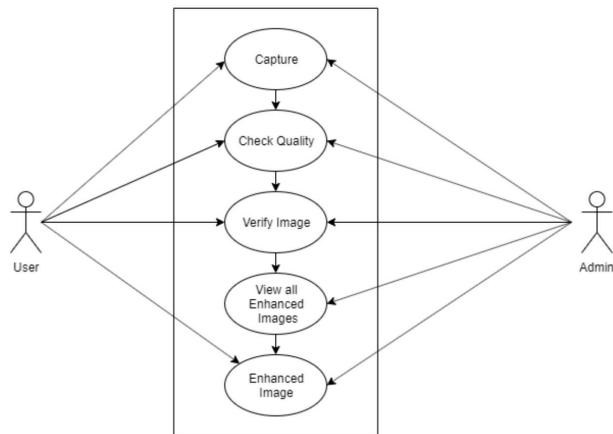


Fig.4. Use-Case Diagram

In level 0 the camera module captures the image or images. It is sent to image enhancement where the image or video is

enhanced. In level 1 image enhancement is expanded. The captured image undergoes white balance. The unwanted artifacts are corrected using gamma correction. The drawbacks of this are rectified by sharpening. Now image fusion is performed to get the enhanced image.(Fig.5.)

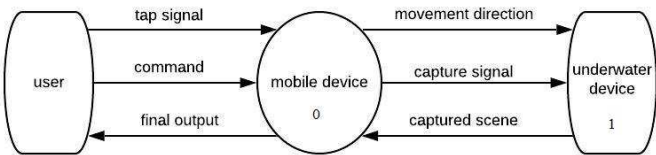


Fig.5. Data Flow Diagram

V. TEST ANALYSIS

A. Object Detection

For the enhancement to take place efficiently objects has to first be identified and categorized. Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class in digital images and videos. Well-researched domains of object detection include face detection and pedestrian detection. Object detection has applications in many areas of computer vision, including image retrieval and video surveillance. Below is a test image containing a bottle underwater.



Fig.6. Test Image

After passing the test image through the object detection algorithms we have the resulting image below. Here you can see that the algorithm has detected the bottle in the input image.



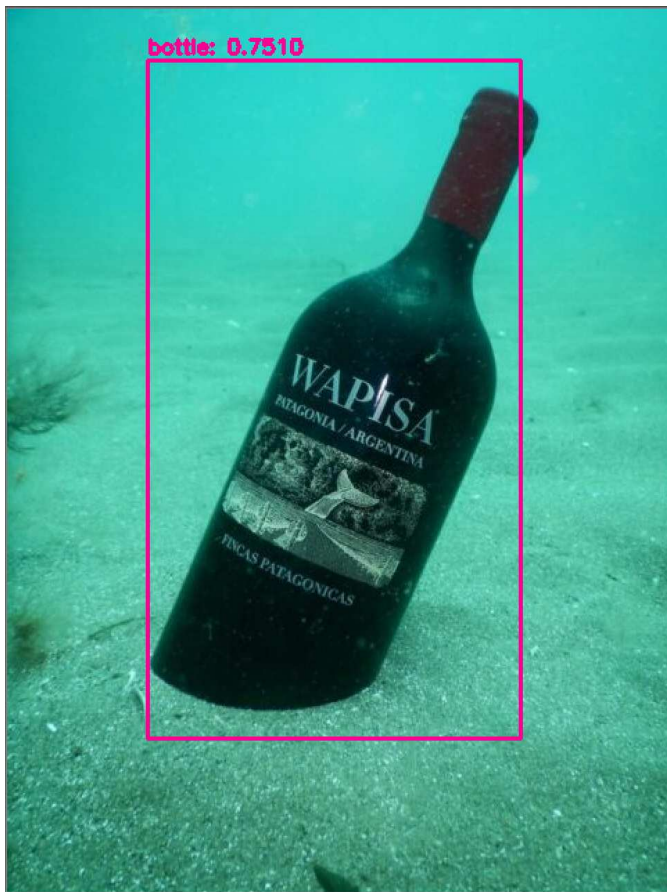


Fig.7. Final Image

### B. Gamma Correction

Gamma encoding of images is used to optimize the usage of bits when encoding an image, or bandwidth used to transport an image, by taking advantage of the non-linear manner in which humans perceive light and color. The human perception of brightness, under common illumination conditions (neither pitch black nor blindingly bright), follows an approximate power function (no relation to the gamma function), with greater sensitivity to relative differences between darker tones than between lighter tones, consistent with the Stevens power law for brightness perception. If images are not gamma-encoded, they allocate too many bits or too much bandwidth to highlights that humans cannot differentiate, and too few bits or too little bandwidth to shadow values that humans are sensitive to and would require more bits/bandwidth to maintain the same visual quality.

Below is a test image before the gamma correction.



Fig.8. Test Image

The image below is the gamma corrected image. The gamma variable is automatically selected from values 0.5(min light)

to 3.0(max light). The variable is selected from a series of algorithms to match the background darkness to the optimal visible brightness. The value varies with images depending on the background illumination.

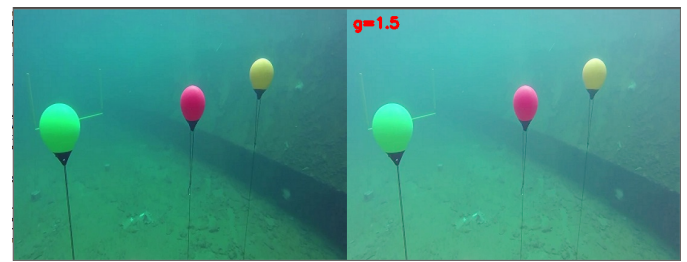


Fig.9. Final Image

### CONCLUSION

We have presented an alternative approach to enhance underwater videos and images and to implement this on a remote controlled device. Apart from common images, underwater images suffer from poor visibility resulting from the attenuation of the propagated light, mainly due to the absorption and scattering effects. The absorption substantially reduces the light energy, while the scattering causes changes in the direction of light propagation. They result in foggy appearance and contrast degradation, making distant objects appear misty. Our strategy builds on the principle of fusion and does not require additional information than the single original image. We have shown in our experiments that our approach is able to enhance a wide range of underwater images with high accuracy, being able to recover important faded edges and features. In future we can explore new techniques and methods including object detection to incorporate so as to increase the efficiency of the proposed system.

### References:

- [1] R. Schettini and S. Corchs, "Underwater image processing: state of the art of restoration and image enhancement methods", EURASIP J. Adv. Signal Process., vol. 2010, 2010.
- [2] D.-M. He and G. G. L. Seet, "Divergent-beam LiDAR imaging in turbid water", Opt. Lasers Eng., vol. 41, pp. 217231. 2014.
- [3] M. Levoy, B. Chen, V. Vaish, M. Horowitz, I. McDowall, and M. Bolas, "Synthetic aperture con-focal imaging", in Proc. ACM SIGGRAPH, Aug. 2004, pp. 825 834. 2014.
- [4] G. Buchsbaum, "A spatial processor model for object colour perception", J. Franklin Inst., vol. 310, no. 1, pp. 126, Jul. 1980, 1980.
- [5] T. Mertens, J. Kautz, and F. Van Reeth, "Exposure fusion: A simple and practical alternative to high dynamic range photography", Comput. Graph. Forum, vol. 28, no. 1, pp. 161171, 2009.
- [6] P. Burt and T. Adelson, "The laplacian pyramid as a compact image code", IEEE Trans. Commun., vol. COM-31, no. 4, pp. 532540, Apr. 1983, 1983.
- [7] SC Huang, FC Cheng, YS Chiu, "Efficient Contrast Enhancement Using Adaptive Gamma Correction With Weighting Distribution", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 22, NO. 3, MARCH 2013, 2013.
- [8] C Papageorgiou, T Poggio, "A Trainable System for Object Detection", International Journal of Computer Vision 38(1), 1533, 2000.